NAVAL MEDICAL RESEARCH UNIT SAN ANTONIO

# INCORPORATION OF CAD/CAM RESTORATIONS INTO NAVY DENTISTRY


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## *Declaration of Interest*

*The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government.* *This work was funded by work unit number G1024.* *Authors are either military service members or employees of the US Government. This work was prepared as part of their official duties. Title 17 USC §105 provides that 'copyright protection under this title is not available for any work of the US Government.' Title 17 USC §101 defines a US Government work as a work prepared by a military service member or employee of the US Government as part of that person's official duties.*

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## ABBREVIATIONS

| | |
|---|---|
| 3D | Three dimensional |
| ANOVA | One-Way Analyses of Variance |
| CAD/CAM | Computer-aided design/Computer-assisted manufacturing |
| CDT | Common Dental Terminology |
| DENCAS | Dental Common Access System |
| DTF | Dental treatment facilities |
| DWV | Dental Weighted Values |
| FY | Fiscal Year |
| ODR | Operational dental readiness |
| PFM | Porcelain Fused to Metal |
| PPM | Personnel per month |

## EXECUTIVE SUMMARY

**Background:** The primary mission of Navy Dentistry is maintaining a high state of operational dental readiness to reduce avoidable dental emergencies for deployed sailors and marines. Dental Computer-aided design/Computer-assisted manufacturing (CAD/CAM) systems are potentially useful tools for increasing dental readiness in a timely manner with high quality clinical results. The placement rates of CAD/CAM restorations were tracked starting October 2011 but have not been evaluated to determine the usage by Navy dental providers.

**Objective:** This report will review and evaluate the placement rate by Navy dentists of digitally fabricated in-office ceramic restorations compared to traditional direct restorations or indirect restorations fabricated in the laboratory.

**Methods:** Using the Dental Common Access System to access dental procedure code counts, researchers analyzed monthly rates for dental procedures associated with CAD/CAM and traditional laboratory fabricated restorations recorded from January 2008 until July 2015. Using multiple linear regression to control for seasonality, the change in the monthly placement rate was calculated for 10,000 personnel per month (PPM).

**Results:** Overall, coronal coverage restorations dropped between October 2011 and July 2015 (-0.450 PPM, $p<0.001$), which can primarily be attributed to the decreases in 4+ surface amalgam restorations (-0.407 PPM, $p <0.001$) and porcelain fused to metal restorations (-0.158 PPM, $p<0.001$). In contrast, monthly ceramic and CAD/CAM restoration placement rates increased significantly (0.050 PPM, $p < 0.001$) and (0.083 PPM, $p<0.0001$), respectively. While metal crown placements decreased significantly ($p = 0.021$), the impact was rather small (-0.019 PPM)

**Conclusions:** The increase in CAD/CAM and ceramic restorations provides a glimpse into a larger trend in Navy dentistry, more aesthetically appealing restorations being placed in lieu of more traditional, less aesthetic restorations. Navy Dentistry has embraced the role of CAD/CAM systems in the provision of dental care to Navy and Marine Corps service members in order to meet operational and mission objectives. Further, the number of CAD/CAM restorations is likely to increase over the next few years.

## INTRODUCTION

The primary mission of Navy Dentistry is maintaining a high state of operational dental readiness (ODR) to reduce avoidable dental emergencies for deployed sailors and marines[1]. Dental Computer-aided design/Computer-assisted manufacturing (CAD/CAM) systems are potentially useful tools for increasing dental readiness in a timely manner with high quality clinical results. In the military traditional indirect restorations, such as a crown which covers an entire tooth, are typically sent to regional dental laboratories with a turn-around time of usually four to six weeks[2]. Longer lab processing times equate to longer periods of time that the active duty personnel remain in a non-deployable status. In addition, temporary restorations, which are used to cover the prepared portion of the tooth and to maintain normal function prior to the delivery of permanent restorations, are prone to dislodgment or fracture when left in place for extended periods. This creates unnecessary burdens for sailors, marines and the overall military healthcare system[3]. Chairside milled CAD restorations can be delivered at a single visit[4], which may dramatically improve dental readiness and deployability status for sailors and marines and their respective units.

Dental restorative materials to replace missing tooth structure or the whole tooth can be broadly categorized as direct or indirect. Direct restoration involves placing restorative materials, such as dental amalgam and resin-based composites, directly into the preparation of the tooth cavity, which usually can be accomplished in a single visit. Due to the compressive strength of dental amalgam restorations, these direct restorations served ideally as restorative material in posterior teeth and as a replacement for coronal (crown) tooth structure. Indirect restorations are typically placed when a large amount of tooth structure needs to be replaced or a full-coverage restoration is required to protect the tooth. General categories of indirect restorations include crowns, onlays, and veneers using restorative materials that range from all-ceramic and metal-

ceramic hybrids to cast-gold alloys. In order to complete the traditional indirect laboratory-fabricated restoration, an impression of the prepared tooth is taken using an elastomeric material and a provisional restoration is prepared to protect the tooth. The provisional restoration, required due to the time required to fabricate the restoration in the laboratory, is typically made of resin or acrylic and is only intended to survive for several weeks. Once the final restoration has been fabricated, the patient is appointed and the restoration permanently bonded with a cement system. The procedure usually involves at least two visits to the dental office.[5]

A CAD/CAM system utilizes digital technology for scanning, designing, developing, and producing a dental restoration or prosthesis. The scanning device converts the shape of the prepared teeth into three dimensional (3D) units of information that are used by software to translate the information into a 3D map. The operator designs a restoration shape using the CAD/CAM system software to generate a tool path. The tool path allows the chairside or laboratory based milling device to grind and shape a pre-selected dental porcelain block into a final restoration with the desired geometry that is ready to be placed onto the tooth. With the development of CAD/CAM technology, indirect restorations can now be completed chairside in a single visit, without the need for a provisional restoration.[6]

CAD/CAM dentistry, with its improved ease of use, allows dentists in many cases to provide high quality aesthetic treatment to patients in a single setting, avoid long-term temporization of the prepared tooth, and positively impact the military member's ODR. The greatest advantage of CAD/CAM is the single appointment concept where the tooth is prepared, an optical impression taken, the restoration is virtually designed, milled, customized and delivered all in one sitting.[7] This eliminates several clinical steps which are time consuming and invasive, as well as the traditional technique sensitive and labor intensive laboratory procedures.

This report will review and evaluate the placement rate by Navy dentists of digitally fabricated in-office ceramic restorations compared to traditional direct restorations or indirect restorations fabricated in the laboratory.

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## METHODS

All dental procedures completed by US Navy dentists at Navy and Marine Corps dental treatment facilities (DTFs) are recorded in the Dental Common Access System (DENCAS). Procedure codes entered into DENCAS to track productivity are based on the Department of Defense Common Dental Terminology (CDT) Dental Procedure Codes and Dental Weighted Values (DWV). Using DENCAS to access dental procedure code counts, researchers analyzed monthly totals for dental procedures associated with CAD/CAM and traditional laboratory fabricated restorations recorded from January 2008 until July 2015. Dental procedure codes for 4+ surface amalgams were also included in the analysis as these restorations often serve similar functions, coronal coverage and cusp replacement, as CAD/CAM and traditional indirect restorations. Table 1 summarizes the DENCAS codes which were used for the study. Individual CDT codes were grouped into categories designated as CAD/CAM, Amalgam, Onlay, Ceramic/Resin, Porcelain Fused to Metal (PFM), or Metal Crown.

Data analyzed in this study incorporated placement rates of traditional direct restorations and indirect laboratory fabricated restorations since January 2008 and CAD/CAM restoration placement rates since October 2011. Monthly totals were tabulated for each general CDT code category listed in Table 1 and summarized in Table 2 as an average of monthly placement rates per fiscal year (FY) and reported with standard deviations. Monthly placement rates were calculated as the total number of restorations in a given month divided by the Navy and Marine Corp active duty service member population number acquired from the Defense Manpower Data Center. Only three-fourths of FY 2008 data were included due to the limitations of the procedure code database. Due to the limited amount of onlay procedures completed, monthly placement rates were not presented in Table 2. For each general CDT code category, one-way Analyses of Variance (ANOVAs) with significance levels defined as $\alpha=0.05$ tested for significant differences

between FY monthly average placement rates. Independent two-sample *t*-tests with significance set at $\alpha=0.05$ compared general category monthly average placement rates for the time periods of January 2008–October 2011 and October 2011–July 2015 (before/after documentation of CAD/CAM placements). All placement rates were given as per 10,000 personnel per month (PPM).

Scatterplots of monthly placement rates were created for all coronal coverage restorations combined and for each general category and overlaid with a simple linear regression line with a respective 95% confidence interval (Figures 1-4). To control for seasonality occurring in the data, multiple linear regression was performed using a categorical variable which split each year into seasonal quarters. As CAD/CAM was not introduced until the first fiscal quarter of 2012, regression analysis was completed only on data reported from October 2011 to July 2015 with the exception that the total placement rate is examined both from January 2008 to July 2015 and from October 2011 to July 2015. Using multiple linear regression, monthly change in the placement rates are reported with their respective 95% confidence intervals and P-values in Table 3. The Coefficient of Determination ($r^2$) was also calculated and reported in Table 3 in order to demonstrate the approximation of the regression line to the real data points. Regression results for the seasonality variable are not shown.

This study was reviewed by the Naval Medical Research Unit San Antonio Institutional Review Board and determined not to involve human subject research. Statistical analysis was conducted using SAS v9.4 and R version 3.3.3.

**Table 1: Codes on Dental Procedures and Nomenclature (CDT)**
**of Milled & Non-Milled Restorative Procedures**

| Procedure | General Category |
|---|---|
| A2642 Onlay - chairside milled porcelain/ceramic - two surfaces | CAD/CAM |
| A2643 Onlay - chairside milled porcelain/ceramic - three surfaces | |
| A2644 Onlay - chairside milled porcelain/ceramic - four or more surfaces | |
| A2662 Onlay - chairside milled composite CAD/CAM - two surfaces | |
| A2663 Onlay - chairside milled composite CAD/CAM - three surfaces | |
| A2664 Onlay - chairside milled composite CAD/CAM - four or more surfaces | |
| A2740 Crown - chairside milled porcelain/ceramic | |
| D2161 Amalgam - four or more surfaces | Amalgam |
| D2542 Onlay - metallic - two surface | Onlay |
| D2543 Onlay - metallic - three surface | |
| D2544 Onlay - metallic - four or more surfaces | |
| D2642 Onlay - porcelain/ceramic - two surfaces | |
| D2643 Onlay - porcelain/ceramic - three surfaces | |
| D2644 Onlay - porcelain/ceramic - four or more surfaces | |
| D2662 Onlay - resin-based composite - two surfaces | |
| D2663 Onlay - resin-based composite - three surfaces | |
| D2664 Onlay - resin-based composite - four or more surfaces | |
| D2710 Crown - resin-based composite (indirect) | Ceramic/Resin |
| D2712 Crown - ¾ resin-based composite (indirect) | |
| D2740 Crown - porcelain/ceramic substrate | |
| D2750 Crown - porcelain fused to high noble metal | PFM |
| D2751 Crown - porcelain fused to predominantly base metal | |
| D2752 Crown - porcelain fused to noble metal | |
| D2790 Crown - full cast high noble metal | Metal Crown |
| D2791 Crown - full cast predominantly base metal | |
| D2792 Crown - full cast noble metal | |

## RESULTS

Average monthly coronal coverage restoration placement rates for FY 2008 through FY 2015 are reported in Table 2. Data were not available for CAD/CAM restorations prior to FY 2012 as these restoration types were not tracked until October 2011.

Coronal coverage restoration monthly placement rate data acquired from DENCAS from January 2008 until July 2015 demonstrated annual seasonal patterns of low and high monthly placement rates. Peak monthly placement rates occurred during the spring and summer months and off-peak rates occurred during the fall and winter months. After controlling for this seasonality through multiple linear regression, the rate of coronal coverage restorations placed or delivered by Navy dentists per 10,000 PPM significantly declined ($r^2$= 0.553, PPM= -0.187, p<0.0001) from January 2008 to July 2015 (Figure 1, Table 3). Further, when examining this same rate for only after CAD/CAM placements began in October 2011, this decline is amplified ($r^2$= 0.589, PPM= -0.450, p<0.0001) (Figure 2, Table 3). Total coronal coverage restoration monthly placement rates peaked in April 2008 with 65.00 per 10,000 and declined to a low of 31.90 per 10,000 in November 2014.

The majority of the decline between October 2011 and July 2015 can be attributed to significant decreases in placement rates of 4+ surface amalgam restorations ($r^2$= 0.7809, PPM= -0.407, p<0.0001) (Figure 2, Table 3) and PFMs ($r^2$= 0.8035, PPM= -0.158, p<0.0001) (Figure 2, 3, Table 3). The greatest monthly placement rate of amalgam restorations was 39.95 PPM in April 2008 and the lowest was 11.81 PPM in February 2015. Similarly, the rate of PFM restorations peaked in April 2009 (15.62) and bottomed in November 2014 (4.08). Further, average monthly placement rates of PFM restorations differed significantly when comparing the periods of data collection before and after October 2011 (12.42 ± 1.58, 8.27 ± 2.40, p < 0.001) (Table 2).

When comparing metal crown restoration rates before and after CAD/CAM restorations were tracked by the Navy (October 2011), there was no significant difference in average monthly placement rates (6.28 ± 0.80, 6.22 ± 0.93, p=0.768) (Table 2). However, metal crown restoration monthly placement rates decreased significantly between October 2011 and July 2015 ($r^2$= 0.469, PPM = -0.019, p=0.021). (Figure 3, Table 3)

In contrast to the overall decline of coronal coverage restorations being placed between October 2011 and July 2015, monthly ceramic restoration placement rates increased significantly ($r^2$= 0.439, PPM = 0.050, p<0.0001) (Figure 4, Table 3). Average monthly ceramic placement rates increased significantly after October 2011 (4.71 ± 1.27, 5.80 ± 1.44 p=0.002) (Table 2). Similarly, since the inception of tracking CAD/CAM restoration procedures in October 2011, monthly CAD/CAM placement rates demonstrated a significant steady increase ($r^2$= 0.6776, PPM = 0.083, p<0.0001) (Figure 3, 4 Table 3).

**Table 2: Average of Monthly Placement Rates of Milled and Various Restorations Procedures Per Fiscal Year Period**

| | CAD/CAM* | PFM*† | Ceramic*† | Metal | Amalgam*† | Total (Ave)* |
|---|---|---|---|---|---|---|
| **FY 2008** | - | 13.86 (0.98) | 3.65 (1.53) | 6.36 (0.76) | 35.15 (1.97) | 59.36 (3.01) |
| **FY 2009** | - | 12.76 (1.51) | 4.51 (1.12) | 6.11 (0.86) | 31.57 (2.00) | 55.39 (4.59) |
| **FY 2010** | - | 11.82 (1.20) | 4.82 (0.85) | 6.15 (0.86) | 29.19 (2.82) | 52.68 (4.93) |
| **FY 2011** | - | 11.59 (1.60) | 5.60 (0.98) | 6.51 (0.74) | 28.86 (2.05) | 52.98 (4.04) |
| | **CADCAM Data Collection Initiated in 1st Quarter FY 2012** | | | | | |
| **FY 2012** | 3.67 (1.31) | 11.02 (1.39) | 5.00 (0.79) | 6.74 (0.91) | 27.99 (1.93) | 54.58 (4.30) |
| **FY 2013** | 4.97 (1.11) | 9.30 (1.08) | 5.62 (1.07) | 6.06 (0.88) | 26.78 (2.69) | 52.86 (4.89) |
| **FY 2014** | 5.38 (0.70) | 6.46 (1.08) | 5.78 (0.86) | 5.88 (0.43) | 18.26 (4.22) | 41.91 (6.01) |
| **FY 2015** | 6.86 (1.40) | 5.90 (1.25) | 7.01 (2.19) | 6.22 (1.24) | 15.08 (2.30) | 41.27 (7.36) |

*$p$<0.05, Comparing Differences in FY

† p<0.05, Comparing FY08-11 vs. FY12-15

Rate = per 10,000 personnel per month

**Table 3: Change in Monthly Utilization Rates by PPM and Corresponding 95% CIs**

| Procedure | △ PPM | 95% CI | P value | Coefficient of Determination ($r^2$) |
|---|---|---|---|---|
| **Total (January 2008 - July 2015)** | -0.187 | (-0.230, -0.145) | <0.001 | 0.523 |
| **Total (October 2011 - July 2015)** | -0.450 | (-0.576, -0.324) | <0.001 | 0.589 |
| **Amalgam** | -0.407 | (-0.476, -0.338) | <0.001 | 0.780 |
| **PFM** | -0.158 | (-0.183, -0.132) | <0.001 | 0.804 |
| **Metal** | -0.019 | (-0.035, -0.003) | 0.021 | 0.469 |
| **Ceramic** | 0.050 | (0.024, 0.076) | <0.001 | 0.439 |
| **CAD/CAM** | 0.083 | (0.062, 0.1035) | <0.001 | 0.678 |

Each row represents a separate linear regression using both time and season as covariates. Seasonal covariates are not reported.

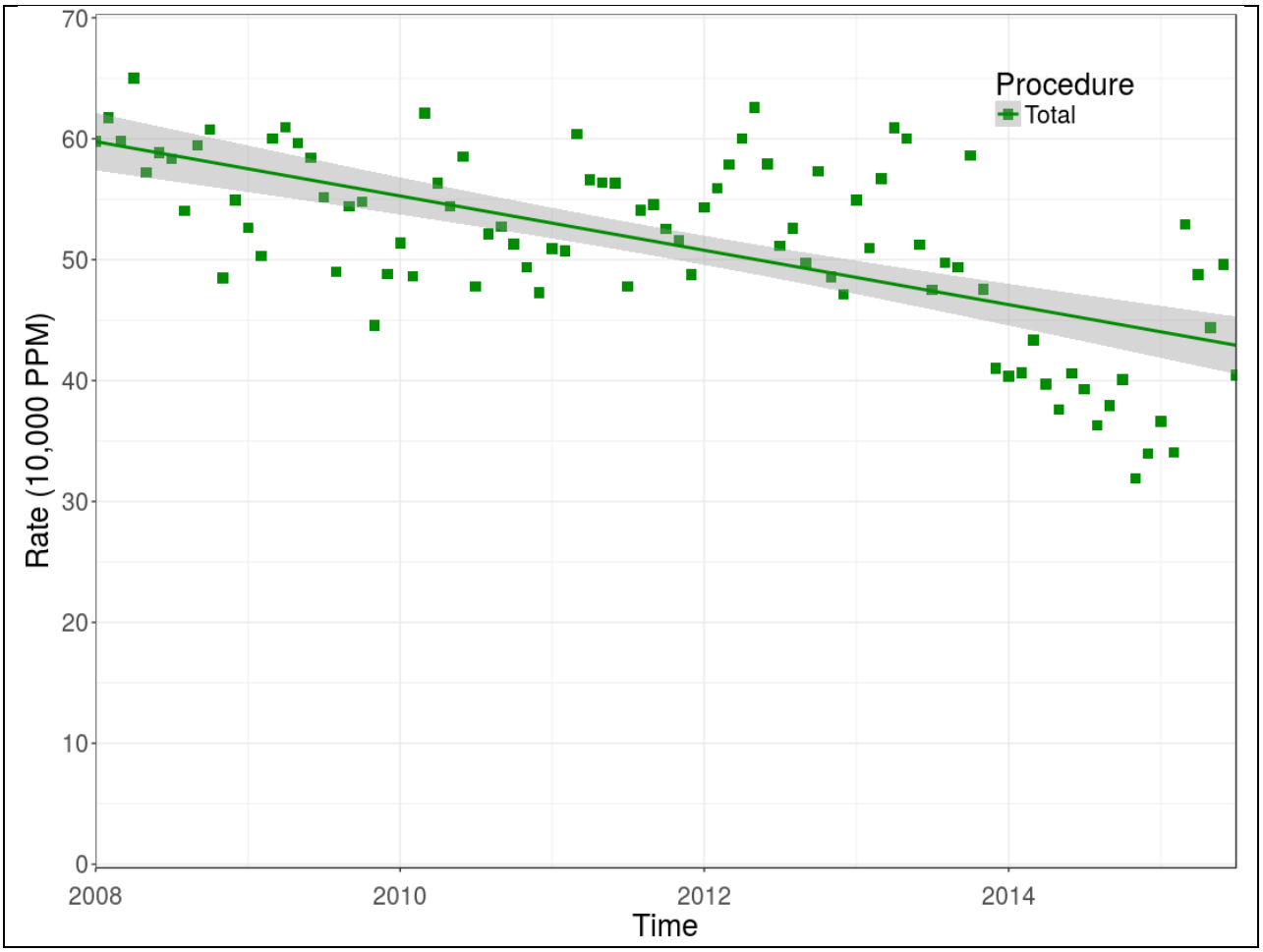


**Figure 1: Coronal coverage restorations placement rates per 10,000 personnel per month (PPM) overlaid with simple linear regression line and corresponding 95% CI (Jan. 2008 – July 2015).**

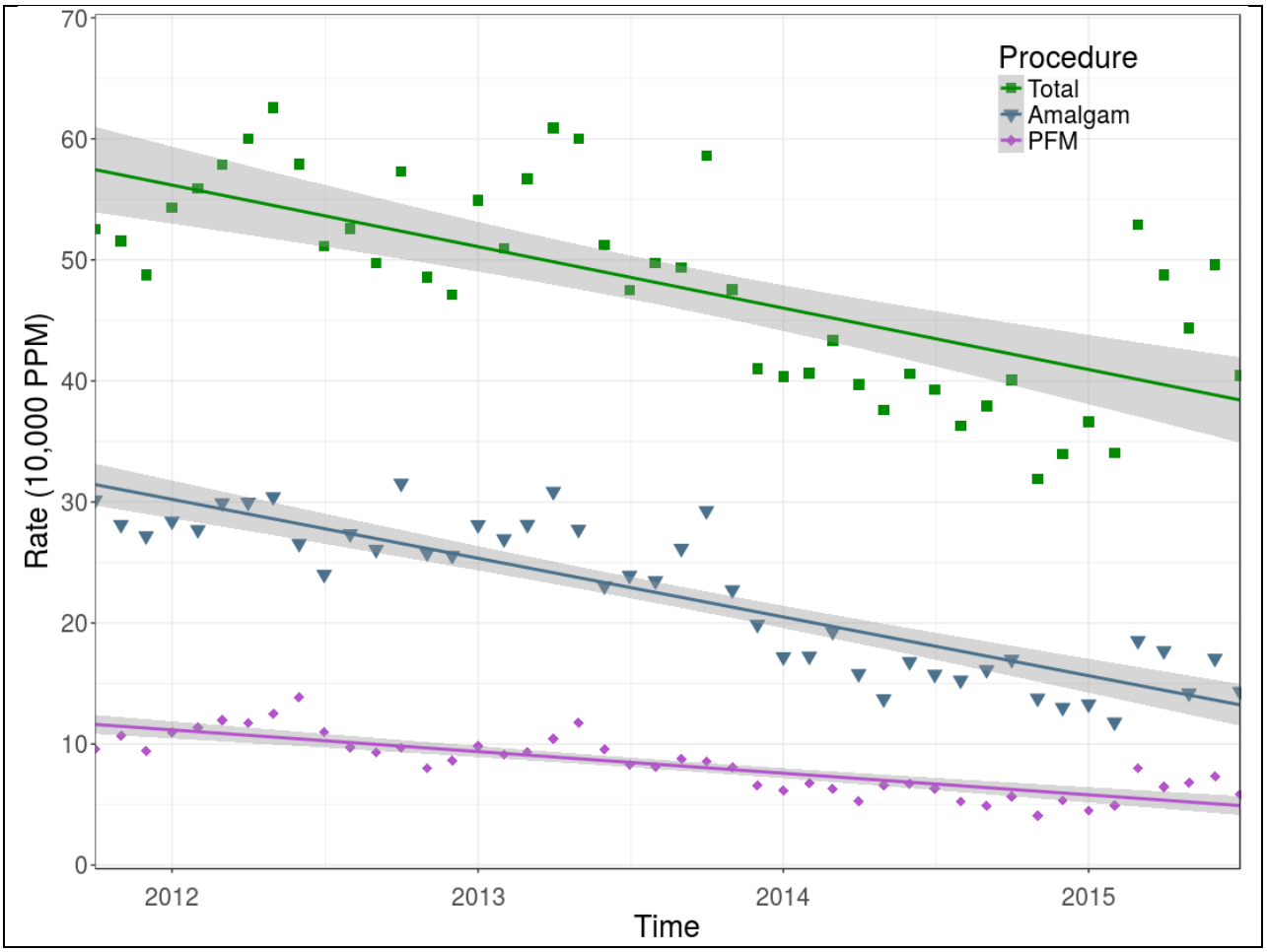


**Figure 2: All coronal coverage, 4+ surface amalgam, and PFM restoration placement rates per 10,000 personnel per month (PPM) overlaid with simple linear regression line and corresponding 95% CI (October 2011 – July 2015).**

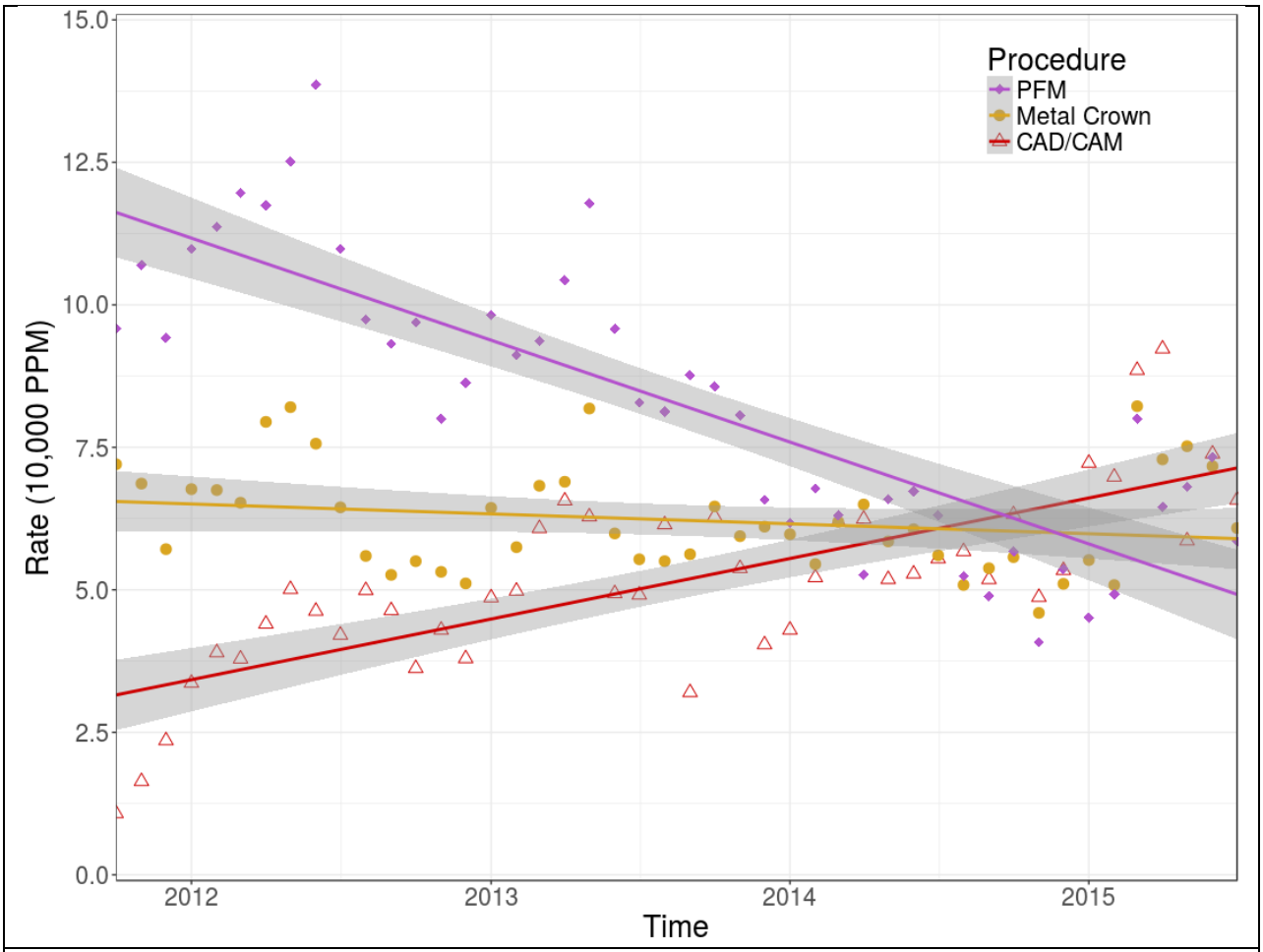


**Figure 3: PFM, Metal, and CAD/CAM restoration placement rates per 10,000 personnel per month (PPM) overlaid with simple linear regression line and corresponding 95% CI (October 2011 – July 2015).**

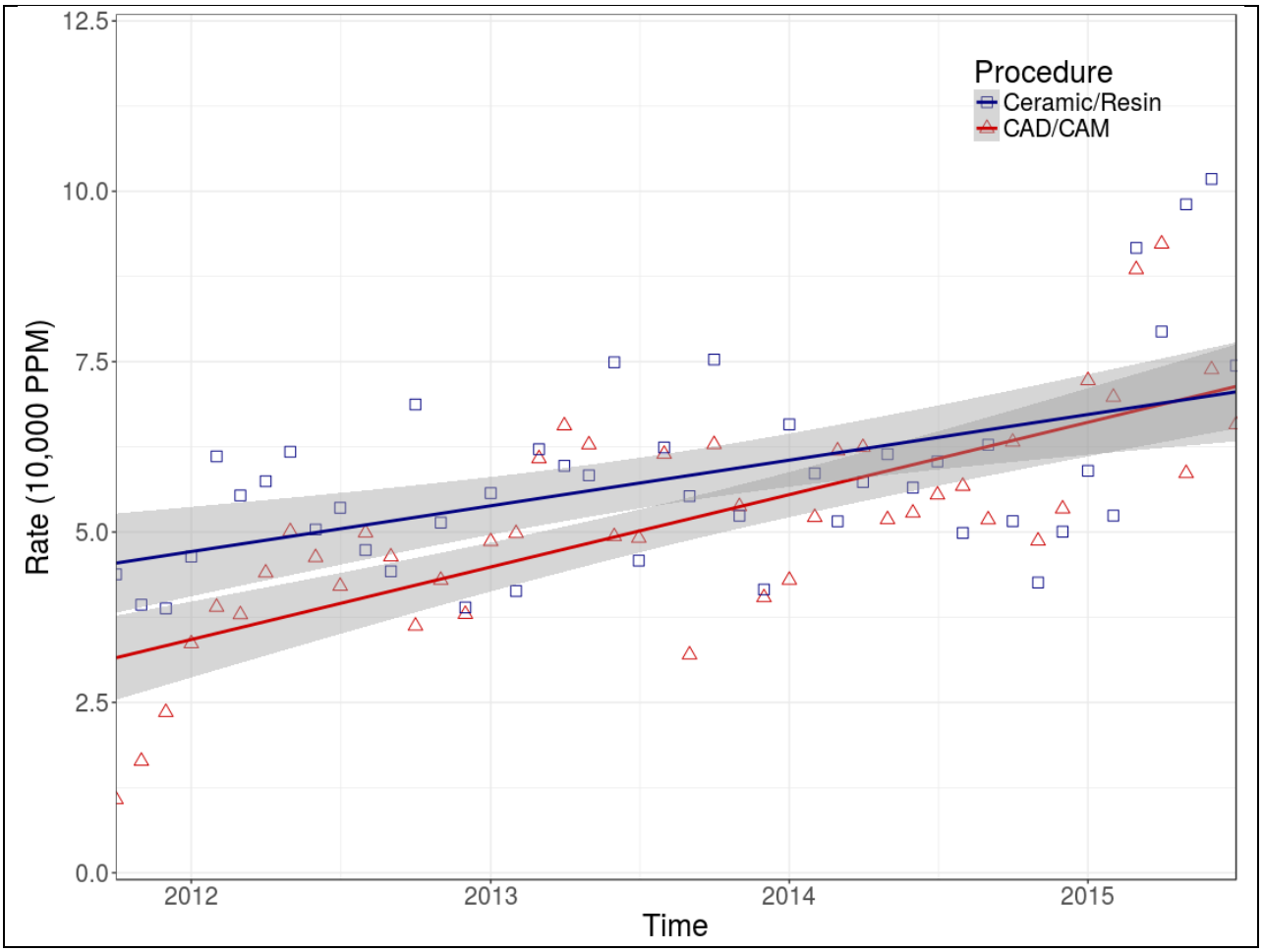


**Figure 4: Full coverage Ceramic/Resin and CAD/CAM restoration placement rates per 10,000 personnel per month (PPM) overlaid with simple linear regression line and corresponding 95% CI (October 2011 – July 2015).**

## DISCUSSION

Data accessed from DENCAS and analyzed in this study reveal that CAD/CAM restoration monthly placement rates have increased since the Navy started tracking production in October 2011. This increase in the rate of CAD/CAM restorations completed by Navy dentists stands in stark contrast to the overall declining placement rate of coronal coverage dental restorations. Even with increasing placement rate trends, CAD/CAM restorations represented only about 16.6% of all coronal coverage restorations in FY 2015, the FY with the highest average monthly CAD/CAM restoration completion rates. During the same FY, traditional coronal coverage restorations – 4+ surface amalgams, metal crowns, and PFMs – accounted for 36.5%, 15.1%, and 14.3%, respectively, of all coronal coverage restorations completed. Together these traditional restorations represented the majority of coronal coverage restorations placed. Despite their relatively small contribution to the overall amount of coronal coverage restorations being completed, the increase of CAD/CAM restorations placed reflect a growing acceptance by Navy providers of CAD/CAM systems and their benefits.

The increase in CAD/CAM restorations provides a glimpse into a larger trend in Navy dentistry, more aesthetically appealing restorations being placed in lieu of more traditional less aesthetic restorations. While PFMs are considered an aesthetic coronal coverage restoration, they are slowly losing favor to faster and similarly aesthetic CAD/CAM restorations. Compared to traditional fabrication time frames (two or more weeks) Navy dentists can now complete, in one appointment, coronal coverage restorations that show similar life cycles to traditional laboratory fabricated indirect restorations and are aesthetically pleasing.

In contrast to increases in aesthetic coronal coverage restoration placement rates and decreases in PFM and 4+ surface amalgam placement rates, average monthly metal crown placement rates remained fairly consistent each FY. While our data showed a statistically

significant decrease in the rate of metal crown placements, the effect was rather small. With a change of -0.019 placements per month, we expect to see only one less metal crown placement every five years per 10,000 personnel. This suggests that metal crowns continue to fulfill a basic need in Navy dentistry. Furthermore, it is impossible from this study to clarify the relationship between PFM placement rate decreases and CAD/CAM increases.

One could argue that since it has been shown that CAD/CAM indirect dental restorations are now a viable and predictable alternative to traditional dental treatment methods,[17] the rapidity of CAD/CAM fabrication has persuaded many dentists to prefer using a CAD/CAM system. Additionally, Navy dentistry has embraced CAD/CAM technology and deployed these systems on multiple naval platforms including ships. Dental clinic directors or individual practitioners may appreciate the potential to reduce patient waiting times and the positive effect on dental readiness and deployability status for sailors and marines. The CAD/CAM system is particularly useful when sailors and marines are deployed globally. With the easy storage and transition of digital impression and design, the restorations can be readily re-done at different DTFs or platforms. Whether these two factors, viable alternative restoration or effect on patient readiness and deployability, are causing the shift in dental practices from traditional PFM restorations to CAD/CAM restorations cannot be determined from this study.

Increased CAD/CAM utilization in the Navy will continue to be limited by various factors associated with CAD/CAM systems. First, many dentists are not trained in the use of the technology and must overcome a learning curve to be able to provide efficient treatment. Second, implementation of CAD/CAM systems in small clinics with limited need for coronal coverage restorations may not be cost effective. Third, not every coronal coverage case is ideally treated with milled restorations. These limiting factors can help explain the small contribution

percentage of CAD/CAM restorations to the total number of coronal coverage restorations. However, the number of CAD/CAM restorations placed is likely to increase for the following reasons: (1) Incorporation of CAD/CAM technology into dental school curricula, (2) Establishment of CAD/CAM systems equipped with intuitive user interfaces, (3) Placement of CAD/CAM technology into all Navy clinics, and (4) Instruction of a greater proportion of dentists in proper CAD/CAM usage.

CAD/CAM usage should be continually monitored to evaluate further utilization changes by Navy dentists. Monitoring placement rates will provide policy makers, strategists, and planners with insight about how to best manage current systems in order to maximize efficiency and usage. Additionally, given the variety and uniqueness of environments in which Navy dentists work, a potential exists to manipulate current CAD/CAM systems in order to better integrate them into all Navy working environments.

Navy Dentistry has embraced the role of CAD/CAM systems in the provision of dental care to Navy and Marine Corps service members in order to meet operational and mission objectives. Based on the data presented from this study the number of CAD/CAM restorations is likely to increase over the next few years. As CAD/CAM restorations account for a greater percentage of coronal coverage restorations, more epidemiological research should focus on the following aspects of CAD/CAM usage: (1) Longevity or survival rate of CAD/CAM restorations placed in sailors and marines, (2) Cost in dollars and manpower of maintaining CAD/CAM units and instructing providers on how to use them, and (3) Influence of dental laboratories on CAD/CAM usage. In general, these aspects will assess the strengths and weaknesses of potentially incorporating CAD/CAM systems into all naval platforms.

## MILITARY SIGNIFICANCE

Navy dentistry's primary focus is to provide quality dental care in a timely manner that maintains a high state of operational readiness for Sailors and Marines. The Craniofacial Health and Restorative Medicine Directorate (CH&RM) at NAMRU-SA is dedicated to assessing dental related factors that influence whether Sailors and Marines remain fit to fight. Currently, warfighters in need of various larger dental restorations such as crowns must wait several weeks while the tooth restoration is fabricated by a technician in a dental laboratory. This delay typically leads to a reduction in operational dental readiness as active duty patients are fitted with a temporary dental crown and remain in a non-deployable status until the procedure is completed. New CAD/CAM systems shorten this time by allowing for rapid scanning, designing, development, and production of dental restorations. Using this technology gives dentists the ability to provide patients with high quality aesthetic treatments in a single setting, making it a potential tool to achieve high operational dental readiness in a rapid manner. This study examined longitudinally the placement rates of digitally fabricated in-office aesthetic restorations compared to traditional laboratory fabricated restorations by providers in Navy DTFs. The results showed that placement of CAD/CAM chairside restorations by Navy providers has increased each year since data collection of CAD/CAM restoration codes began in October 2011. The increase in CAD/CAM restorations demonstrates a growing acceptance and utilization rate by Navy dentists and also underscores CAD/CAM technology's ability to produce esthetically pleasing, functional, time saving and cost-effective dental restorations. Digital dental technology is rapidly expanding among the dental profession and increasingly being utilized by Navy dentists both in shore based and operational settings. The number of CAD/CAM restorations placed is expected to continue rising as more milling devices are placed in Navy dental clinics

and more dentists are trained in their use. The technology is ideal for the military health care environment where the focus is to reduce traditional delays, maintain a high state of dental readiness, and improve patient access during times of high operational tempo.

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**14. ABSTRACT**

The primary mission of Navy Dentistry is maintaining a high state of operational dental readiness to reduce avoidable dental emergencies for deployed sailors and marines. Dental Computer-aided design/Computer-assisted manufacturing (CAD/CAM) systems are potentially useful tools for increasing dental readiness in a timely manner with high quality clinical results. This report reviewed the placement rate by Navy dentists of digitally fabricated in-office ceramic restorations compared to traditional direct restorations or indirect restorations fabricated in the laboratory. Data records for dental procedure code monthly rates for dental procedures associated with CAD/CAM and traditional laboratory fabricated restorations recorded from January 2008 until July 2015 were collected and analyzed. Using multiple linear regression the change in the monthly placement rate was calculated for 10,000 personnel per month (PPM). Overall, coronal coverage restorations dropped between October 2011 and July 2015 (-0.450 PPM, $p<0.001$). In contrast, monthly CAD/CAM placement rates demonstrated a significant steady increase (0.083 PPM, $p<0.0001$). Navy Dentistry has embraced the role of CAD/CAM systems in the provision of dental care to Navy and Marine Corps service members in order to meet operational and mission objectives. Further, the amount of CAD/CAM restorations is likely to increase over the next three to five years.

**15. SUBJECT TERMS**
Computer-aided design, CAD, computer-assisted manufacturing, CAM, coronal restorations, rates, dentistry

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